IMPROVEMENT ON SYSTEM AND COMPONENTS OF A ROTATING ELECTRIC FIELD MILL FOR ATMOSPHERIC ELECTRIC FIELD MEASUREMENT

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Alhamdulillah, all praises to Allah

Dedicated, in thankful appreciation for doa, support, encouragement and understanding
to my beloved father, Shahroom Omar, mother Nor'Aini Haron
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grandfather Haji Omar
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ABSTRACT

Lightning, which is also known as the separation of electrical charges in atmosphere, performs energetic discharge. Monitoring of the atmospheric electric field (AEF) helps to provide precaution against the risks of lightning. The rotating electric field mill (REFM) is a sensor used in measuring AEF. For long-term research, REFM should be modified based on several criteria to improve its effectiveness, cost efficiency and functionality. Studies on the applications of several sensor materials on the performance of REFM are limited. The current research's purpose is to improve REFM as AEF sensor. Furthermore, this research aims to identify the ability of REFM to capture lightning impulses and to track thundercloud development processes and movements. REFM comprises of signal processing circuit (consisting of amplification unit, filtering, conversion and signal conditioning unit) for establishing connection to data acquisition equipment in order to display, collect and analyse data. The calibration and HV impulse experiment have been conducted to this REFM. Moreover, the materials used to develop REFM sensor were mainly made from aluminium or stainless steel. Therefore, an investigation on different materials of REFM rotor and stator was performed to examine their sensitivity and stability towards the high voltage atmosphere. In addition, in order to investigate the characteristics of the signal obtained from a thunderstorm cloud prior to cloud ground lightning discharges, the REFM was installed in an open area. The calibration results showed that the aluminium sensor is more suitable for AEF measurement compared to the stainless steel sensor. The data collected on-site revealed the characteristics of the signals of AEF in the atmosphere as well as the characteristics of the signal from a thunderstorm cloud prior to cloud ground lightning discharges. This research introduced a new design of REFM which offers a reduction of up to one-third of the regular cost of the commercial REFM.

ABSTRAK

Kilat, yang juga dikenali sebagai pemisahan cas elektrik di atmosfera, membebaskan aliran tenaga. Pemantauan medan elektrik atmosfera (AEF) membantu dalam menyediakan langkah berjaga-jaga terhadap risiko kilat. REFM merupakan sejenis sensor yang digunakan dalam pengukuran AEF. Bagi penyelidikan jangka panjang, REFM perlu diubahsuai berdasarkan beberapa kriteria untuk meningkatkan keberkesanan, kecekapan kos dan fungsinya. Kajian yang telah dilakukan melibatkan kepelbagaian dalam penggunaan bahan sensor yang berkaitan dengan prestasi REFM adalah terhad. Tujuan penyelidikan ini adalah untuk menambahbaikkan REFM sebagai sensor AEF. Di samping itu, kajian ini juga mengenal pasti keupayaan REFM untuk mengesan impuls kilat dan menjejaki proses perkembangan dan pergerakan petir. REFM terdiri daripada litar pemprosesan isyarat (yang terdiri daripada unit amplifikasi, penapisan, penukaran dan unit pelaziman isyarat) bagi mewujudkan pautan kepada peralatan pemerolehan data untuk memapar, mengumpul dan menganalisis data. Penentukuran dan eksperimen impuls HV telah dijalankan untuk REFM ini. Selain itu, bahan yang digunakan untuk membina sensor REFM kebanyakannya diperbuat daripada aluminium atau keluli tahan karat. Oleh itu, siasatan ke atas bahan-bahan yang berbeza pada pemutar dan pemegun REFM telah dilakukan untuk mengkaji kepekaan dan kestabilannya terhadap persekitaran bervoltan tinggi. Di samping itu, bagi mengkaji ciri-ciri isyarat yang diperolehi dari awan ribut petir sebelum pelepasan kilat awan ke bumi, REFM telah dipasang di kawasan terbuka. Hasil kajian menunjukkan bahawa penentukuran sensor aluminium adalah lebih sesuai untuk pengukuran AEF berbanding sensor keluli tahan karat. Data yang diperolehi daripada lokasi mendedahkan ciri-ciri isyarat AEF di atmosfera dan juga ciri-ciri isyarat dari awan ribut petir sebelum pelepasan kilat awan ke bumi. Kajian ini memperkenalkan reka bentuk baru REFM yang menawarkan pengurangan sehingga satu pertiga daripada kos tetap REFM komersial.